**Enthalpy change calculations**

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| **1)** Methanol and ethanol can both be used as fuels. Their combustion  reactions can be represented by the following equations:  Methanol: 2CH3OH + 3O2 → 2CO2 + 4H2O Δr *H*o = –1450 kJ mol–1  Ethanol: C2H5OH + 3O2 → 2CO2 + 3H2O Δr *H*o = –1370 kJ mol–1  Justify which fuel, methanol or ethanol, will produce more heat energy when  345 g of each fuel is combusted in excess oxygen.  *M*(CH3OH) = 32.0 g mol–1 *M*(C2H5OH) = 46.0 g mol–1 |  |
| **2)** The equation below shows the combustion of butane.  C4H10(*g*) + 13/2 O2(*g*) → 4CO2(*g*) + 5H2O(*g*)  When 100 g of butane undergoes combustion, 4 960 kJ of energy is released.  Calculate the enthalpy change when 1 mole of butane undergoes combustion.  *M*(C4H10) = 58.1 g mol–1 | **3)** The iron oxides Fe3O4 and Fe2O3 react with aluminium as shown below.  3Fe3O4(*s*) + 8Al(*s*) → 4Al2O3(*s*) + 9Fe(*s*) Δr *H*° *= –*3 348 kJ mol–1  Fe2O3(*s*) + 2Al(*s*) → Al2O3(*s*) + 2Fe(*s*) Δr *H*° *= –*851 kJ mol–1  Justify which iron oxide, Fe3O4 or Fe2O3, will produce more heat energy  when 2.00 kg of iron is formed during the reaction with aluminium.  Your answer should include calculations of the heat energy produced for the  given mass of iron formed.  *M*(Fe) = 55.9 g mol–1. |
| **4)** CH4 + 2O2 → CO2 + 2H2O Δr*H* = –889 kJ mol–1  Calculate the energy released when 128 g of methane is burnt.  *M* (CH4) = 16.0 g mol–1. | **5)** Magnesium burns in oxygen to produce magnesium oxide. The equation  for the chemical reaction is be represented by:  2Mg(*s*)+ O2(*g*)🡪2MgO(*s*)∆r*H* = –1200 kJ mol–1  Calculate how much energy is released when 15.4 g of oxygen gas reacts.  Calculate the mass of magnesium that must react to release 98.2 kJ of energy. |
| **6)** The overall reaction occurring in many disposable hand warmers can be represented by:  4Fe(*s*) + 3O2(*g*) → 2Fe2O3(*s*) Δr *H* = –1652 kJ mol–1  (i) Calculate the energy released when 1.00 mol Fe2O3 is produced.  (ii) Calculate the mass of Fe that would be required to release 185 kJ of  energy. *M*(Fe) = 55.9 g mol–1. | **7)** Hydrogen and methane can be used as fuels.  2H2(*g*) *+* O2(*g*) → 2H2O(*ℓ*) Δr *H* = –570 kJ mol–1  CH4(*g*) + 2O2(*g*) → CO2(*g*) + 2H2O(*ℓ*) Δr *H* = –890 kJ mol–1  Determine which of the fuels, hydrogen or methane, provides the most  energy per gram of fuel burned. Justify your answer with calculations.  *M*(H2) = 2.00g mol–1 *M*(CH4) = 16.0 g mol–1 |
| **8)** When a 12.2 g sample of ammonia is burned, 275 kJ of energy is released.  Calculate the energy released for the reaction below, when four moles of  ammonia are burned.  4NH3(*g*) + 3O2(*g*) → 2N2(*g*) + 6H2O(*ℓ*)  *M*(NH3) = 17.0 g mol–1 | **9)** The equation for the reaction between calcium oxide, CaO, and water can  be represented as  CaO(*s*) + H2O(*ℓ*) → Ca(OH)2(*aq*) Δ*H* = –82.0 kJ mol–1  Calculate the mass of calcium oxide required to release 287 kJ of energy.  *M*(CaO) = 56.0 g mol–1 |
| **10)** When an 18.4 g sample of ethanol is burned, 546 kJ of energy is released. Determine the enthalpy change, Δr*H*, for the reaction when one mole of ethanol is burned.  C2H5OH(*l)* + 3O2(*g*) → 2CO2(*g*) + 3H2O(*l*)  *M*(C2H5OH) = 46.0 g mol–1 | **11)** 29.6 g of sodium hydroxide was dissolved in water and excess hydrochloric acid was added. Using the temperature increase and the heat capacity of water, it was calculated that 43.5 kJ of heat was released.  Determine the enthalpy change, Δr*H*, for the following reaction:  NaOH(*aq*) + HCl(*aq*) → NaCl(*aq*) + H2O(*l*)  What mass of sodium hydroxide is required to produce 150 kJ of energy? |
| **12)** The principle of a fireworks-type explosion can be demonstrated by igniting a sucrose jellybaby with sodium chlorate, NaClO3.  The equation for the explosion reaction is:  2NaClO3(*s*) + C12H22O11(*s*) 2NaCl(*s*) + 9C(*s*) + 3CO2(*g*) + 11H2O(*g*)  Δr *H*° = –2192 kJ mol–1  Calculate the quantity of heat released when one jelly-baby containing 4.56 g of sucrose (C12H22O11) is exploded.  The heat released by the explosion can be used to vaporise strontium chloride to give the fireworks colour.  The heat required to convert SrCl2 from the solid to the gas state is 343 kJ mol–1.  Use your answer to calculate the mass of solid SrCl2 that can be vaporised by exploding one jelly baby containing 4.5 g of sucrose. | **13)** Octane is a key component in petrol, and burns according to the following equation:  C8H18(*l*) + 121–2 O2(*g*) → 8 CO2 (*g*) + 9 H2O(*l*) Δ*rH* = -5500 kJ mol-1  1.00 litre of octane contains 6.12 moles of the fuel. Calculate the energy  released when 1 litre of the fuel is burnt.  Using hydrogen gas (H2) as a fuel for cars, rather than octane, is often  viewed as better for the environment.  Calculate the mass of H2 required to produce the same amount of energy  as 1.00 litre of octane, as calculated in part (b) above. State your answer to  3 significant figures.  H2(*g*) + 1–2 O2(*g*) → H2O(*g*) Δ *rH* = -286 kJ mol-1 |

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